PATENT SPECIFICATION

920,230

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Improvements in or relating to Cyclones for Removing Solids from Gas.

We, COOPERS MECHANICAL JOINTS LIMITED, a British Company, of Llanfoist Works, Abergavenny, Monmouthshire, CHARLES MATHIAS STREETE, of "Bryn-hyfryd," North Street, Abergavenny, Monmouthshire, and STANLEY PAUL WITCHELL, of "Wychwood," off Gypsy Lane, Llanfoist, Abergavenny, Monmouthshire, both British Subjects, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to cyclones for separating solids from gas. Such a cyclone, which is usually symmertical about a vertical axis, includes a vessel in which a stream of gas is caused to whirl so that the solids, owing to their weight, are caused by centrifugal force to reach the wall of the vessel where their velocity is reduced by friction. The solids, therefore, fall to the bottom of the vessel while the cleaned gas is discharged through a coaxial outlet tube leading out of the top of the vessel. The bottom of the vessel is usually of a frusto-conical shape with an axial outlet opening for the impurities. It is well known that the separation of impurities is more effective in small cyclones than in large and it has, accordingly, proved highly practical to use clusters of cyclones to clean the intake air for automative engines. Such clusters may also be used for the air intakes of gas turbines, and also used in air conditioning plants.

One object of the present invention is to increase the air handling capacity of a cyclone of a given size, without loss of efficiency, thus enabling a more compact cluster to be used than would otherwise be possible. While the invention is primarily concerned with gas cleaning units consisting of clusters or groups of cyclones, it also includes gas cleaning units constituted by single cyclones.

According to the invention a cyclone for separating solids from gas includes a vessel, an outlet tube in the form of a venturi tube having an untapered section and an outwardly tapered section leading out of the untapered section and not less than twice the length of the untapered section, and at least one fixed blade mounted in the vessel between the wall of the vessel and the untapered section of the outlet tube, the blade being arranged so as to impart to the gas, as it travels along the blade from its leading to its trailing edge, a component of velocity that is tangentially directed with respect to the vessel, whereby the combined effect of the blade and vessel is to impart a whirling motion to the gas prior to entering the outlet tube.

The vessel and outlet tube preferably are both of circular cross-section and advantageously there may be three blades as aforesaid equidistantly distributed in the annular space between the vessel and outlet tube, the three blades all being in the same axial zone of the cyclone. The outlet tube may have a flared inlet end constituted by a lip which curves outwards to its outer periphery, which may lie on a radius that is approximately half way between the radius of the untapered section of the tube and the radius of the adjacent portion of the vessel. The taper of the tapered section of the outlet tube is preferably such that the angle included by the taper is seven and a half to eight degrees of arc. The venturi shaped outlet tube reduces the losses that arise as the gas vortices are transferred to the tube and discharge, for example to the inlet of

an internal combustion engine, or to the atmosphere. When the venturi outlet tube is used in conjunctiin with blades that are curved so as to impart an increasing component of tangential velocity to the gas, the overall saving of energy, as compared with a conventional cyclone of about the same size with flat blades and a simple cylindrical outlet tube, is about 35% in terms of increased throughput without loss of efficiency. This effect is due to the reduction of internal resistance in the cyclone so that more of the available energy is used for separating the dust from the gas.

The invention also includes internal combustion engines furnished with cyclones as aforesaid, the wide ends of the tapered sections of the outlet tubes being connected to the inlets of the internal combustion engines.

In order that the invention may be clearly understood, one construction in accordance therewith will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a sectional elevation of a cyclone; and

Figures 2 and 3 are respectively a side elevation and a plan of a portion of the cyclone of Figure 1.

In this example, dirty air to be cleaned enters the upper end of a cyclone vessel 1 in a substantially axial direction. The air immediately encounters the leading edges 2 of three blades 3 fixed to a sleeve 4 surrounding an untapered portion 5 of a venturi-shaped outlet tube 6. The width of each blade 3 is such that it extends outwards to the wall of the vessel 1, and the inner and outer edges 7, 8 of each blade follow helical lines on the inner surface of the vessel 1 and the outer surface of the sleeve 4, the blade being soldered to the sleeve 4 along the inner helical line. The pitches of these helical lines are not constant from the leading edge 2 to the trailing edge 9 of each blade, because the blade is curved along its chord so as to impart a smoothly increasing quantum of tangential velocity to the incoming air stream. Thus, the leading portion of each blade is quite steep and the blade gradually becomes less and less steep towards the trailing edge 9. In this example, which has been found suitable for the sort of air velocities encountered in the air intakes of automotive engines, the angle of incidence of the leading edge of the blade with respect to the axially flowing, incoming air is ten degrees of arc. The angle at which the stream leaves the blade is about twenty-three degrees of arc to the horizontal. The well-known "Coanda effect" assists the smooth flow of air over the convex side of the blade.

From Figure 3 it will be seen that, in plan, each blade extends over an arc of ninety degrees between the vessel 1 and outlet tube 6.

The vessel has the usual conical bottom 10 with an outlet 11 through which the separated dust is discharged. The outlet tube 6 has a flared inlet 12 and an expanding tapered outlet 13.

The drawings are to scale and the size of the cyclone can be estimated from the fact that the inside diameter of the vessel 1 is one and three-sixteenths inches. It was found that when tested with dust according to B.S. 1701, an efficiency of 96% to 97.5% was obtained at a pressure loss of only two and a half to nine and a half inches water gauge with volumetric flows of from 6.2 cubic feet per minute to 18 cubic feet per minute.

If desired, the cyclone may be wholly or partly moulded from a synthetic plastic material, such as nylon, polythene, or polypropylene profax.

When a number of cyclones are mounted as a cluster or group, the vessel 1 extend downwards from a common inlet manifold through which the outlet tubes 6 project upwards into a common outlet manifold that can be connected to the air inlet of an internal combustion engine. The outlet manifold may contain a further filter such, for example, as a paper filter. The collected dust is discharged from the vessels into a common container. It is also not impracticable to mount the cluster of cyclones with their axes horizontal.

WHAT WE CLAIM IS:—

1. A cyclone for separating solids from gas including a vessel, an outlet tube in the form of a venturi tube having an untapered section and an outwardly tapered section leading out of the untapered section and not less than twice the length of the untapered section, and at least one fixed blade mounted in the vessel between the wall of the vessel and the untapered section of the outlet tube, the blade being arranged so as to impart to the gas, as it travels along the blade from its leading to its trailing edge, a component of velocity that is tangentially directed with respect to the vessel, whereby the combined effect of the blade and vessel is to impart a whirling motion to the gas prior to entering the outlet tube.

2. A cyclone according to Claim 1, in which the angle of the outwardly tapered section in seven and a half to eight degrees of arc.

3. A cyclone according to Claim 1 or Claim 2, in which the outlet tube has an outwardly flared section leading into the untapered section, the outwardly flared section being constituted by a lip which curves outwards to its outer periphery which lies approximately half way between the radius

of the untapered portion of the tube and the radius of the adjacent portion of the vessel.

4. A cyclone according to any one of the preceding claims, in which there are more than one blade, the blades being similar to one another and in the same axial zone of the cyclone, each blade being formed so that the gas encounters the leading edge of the blade at a substantially zero angle of incidence, and each blade being curved so as to impart an increasing component of tangential velocity to the gas travelling along the blade.

5. A cyclone substantially as described with reference to the accompanying drawings.

6. An internal combustion engine furnished with a cyclone according to any one of the preceding claims, the wide end of the tapered section of the outlet tube being connected to the inlet of the internal combustion engine.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG. 1.

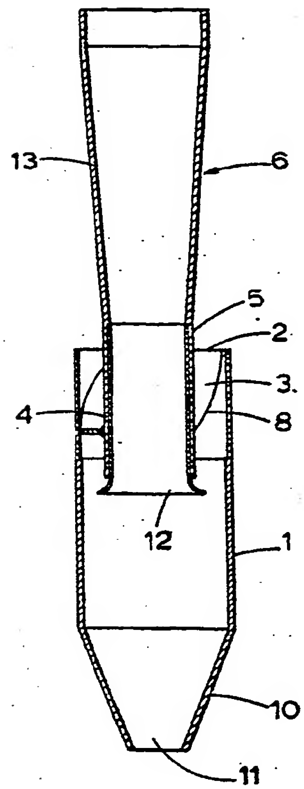

FIG. 2.

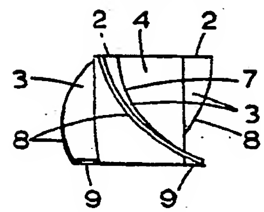

FIG. 3.